

**The Internet as a Business Game Changer:
A Study on Invisible Consumption Spaces
in Nanjing Old City**

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Abstract

With the recent development of online-to-offline (O2O) industries in China, the Internet has become a game-changer, facilitating the creation of new forms of spaces. Taking Nanjing old city as a case study, this paper identifies invisible consumption spaces that are not situated on the streets or in shopping malls but are primarily located inside high-rise buildings and rely on online platforms to operate. The distribution of invisible consumption spaces presents characteristics of central agglomeration and multi-polar clustering. Based on decision tree algorithms, an analysis of a typical area indicates that spatial costs, property rights, and building management and support are the primary influencing factors. Additionally, commercial-residential buildings play a crucial role as carriers of spatial clustering. This paper argues that the emergence and development of invisible consumption spaces is a manifestation of the diversification of old city consumption spaces and a significant bottom-up regeneration strategy in the Internet era.

Keywords

Invisible consumption space, O2O, distribution characteristics, spatial clustering, space regeneration

1 Introduction

Research on consumption spaces initially began in the field of commercial geography, with studies on spatial location primarily based on Christaller's central place theory. Subsequently, as cognitive and behavioural models were proposed, the research perspective expanded to consumption behaviour (Huff, 1963). With the emergence of the information age, the Internet has become a game changer, radically altering the pathways and efficiency of communication, and profoundly transforming urban everyday life spaces. The consumption space based on online-to-offline (O2O) is precisely a new type of urban space that reflects the interplay between the explicit and the implicit.

In recent years, the O2O consumption model has developed rapidly in China. Research on O2O consumption spaces, such as takeaway restaurants, Airbnb houses (Sun, Wang and Hu, 2022), and Internet-sensation shops, has yielded relatively rich results. This research has initially established a framework for studying new types of consumption spaces under the backdrop of Internet development. However, there is an *invisible* O2O in-store consumption type that has not yet attracted much attention. These stores, as physical consumption spaces in the city, do not have storefronts opening directly to urban public spaces (on streets or in shopping malls) but are concealed within urban buildings. They operate through online platforms, focusing on experiential consumption, which mainly includes life services, entertainment, leisure, sports, and other formats. This paper refers to this type of consumption space as *invisible consumption space*. The research in this paper mainly focuses on the distribution characteristics and influencing factors of invisible consumption spaces in the context of the Internet environment. By analysing the data of invisible consumption spaces in Nanjing old city, this study explores the macro-level spatial distribution characteristics. Through case studies of typical blocks and buildings, this study aims to identify and analyse the micro-level site selection factors. The

research findings are expected to enrich and improve the types and contents of old city space regeneration under the influence of the Internet.

2 Research Overview

As information communication technology (ICT) advances, there is a notable shift in the fundamental dimensions of human cognition within the network society. The *space of flows* and *timeless time* have become the new spatial-temporal foundations (Castells, 1996). The social fabric and daily routines are reorganised by electronic communication networks, leading to time-space compression or even the end of geography. The development of ICT has brought new changes to urban space and consumption spaces (Carpio-Pinedo and Gutiérrez, 2020).

Online shopping has impacts on physical consumption spaces through substitution, enhancement, modification, and neutrality (Farak et al., 2007). Corresponding to offline physical consumption spaces, online virtual consumption spaces have emerged (Farak, Krizek and Dijst, 2006), and some traditional shopping has shifted from offline to online, which can have positive or negative impacts on physical spaces (Puel and Fernandez, 2011). Similarly, in addition to the shift from offline to online, online consumption spaces are also expanding offline. This expansion includes new retail spaces and playscapes that host offline leisure activities organised by online communities. Overall, the online-merge-offline development, known as the *bricks-and-clicks* model, is a prevalent trend in the evolution of consumption spaces (Zhen et al., 2018).

The transition of consumption spaces from *visible* to *invisible* is a common feature in numerous studies focusing on spatial distribution influenced by the Internet. Regional-scale studies focus on various industrial spatial patterns and characteristics, as well as the influencing factors among cities. The studies of urban internal scale mainly address the industrial characteristics, influencing factors, and the impact on traditional commercial space. In terms of spatial distribution, O2O consumption spaces tend to extend into back alleys and the interior of blocks horizontally, while showing a concentration trend in high-rise buildings vertically (Lu et al., 2013).

With the increasing emphasis on the cultural significance of consumption, the consumption of space also encompasses the consumption of the *third space* constructed collectively by material, spiritual, and social aspects (Soja, 1996). Consumption spaces are no longer just places for buying goods, but also offer a wider range of experiential sensations. Compared to the traditional rational-functional approach to processing information in consumption, experiential consumption focuses on the symbolic, hedonistic, and aesthetic aspects of the act (Holbrook and Hirschman, 1982). In addition to traditional retail shops, more and more studies involve cultural and recreational places (Chatterton and Hollands, 2002), as well as leisure, festival activities and spaces (Demant and Landolt, 2013; Kidder, 2012). A significant number of retail spaces in cities that cater to in-store consumers are being influenced by online shopping trends and are aiming to transition into experiential shopping destinations, possibly evolving into tourist attractions (Gilli and Ferrari, 2017). Experience is a key value in the O2O consumption

process. In general, the consumption of consumption spaces is becoming increasingly important, while the importance of location is diminishing.

Overall, research on consumption spaces in the context of the Internet is mainly concentrated in the field of urban geography, focusing on consumption behaviour and meaning, with some involving location and distribution. However, research from the perspective of space regeneration is relatively weak, especially systematic research on invisible consumption spaces, which requires further in-depth exploration.

3 Macro Distribution Characteristics of Invisible Consumption Spaces

3.1 Data Source and Processing

The study utilises Point of Interest (POI) data for the consumption spaces in Nanjing old city, which was obtained through the Gaode Open Platform (an application of Amap.com, one of the most popular digital maps in China). Each POI represents a single store (consumption space). The Gaode Open Platform provides comprehensive and complete open-source data, and it covers both offline and O2O consumption spaces, facilitating comparative research. Additionally, the data is linked to Dianping.com, a popular review platform in China similar to Yelp in Europe. This link provides information such as online reviews and average consumption per person, which aids in collecting characteristics of O2O consumption.

The data for this study was collected on 28 November, 2019, a time when the data had not yet been affected by COVID-19. The data is categorised according to the 'National Economic Industry Classification (GB/T 4754-2017)' and the POI classification codes from the Gaode Open Platform. These categories are divided into seven major groups: catering services, shopping services, educational services, life services, entertainment services, sports and leisure services, and medical services (Table 1).

Table 1. Summary of data on consumption spaces (shops) in Nanjing old city

Shop name	Name
Location	Administrative districts, latitude and longitude coordinates, and address texts
Floor levels	Extracted from address texts
Categories	Seven categories, and several subcategories
Online reviews	Ratings, and consumption per person

Data source: The floor levels are extracted according to the address text, and the other information is obtained through the Gaode Open Platform.

The article extracts POI data based on the definition of invisible consumption spaces. Consumption spaces can be categorised into two types based on their environment: street shops and internal shops. Street shops are visible consumption spaces with storefronts facing the street. In contrast, internal shops are located within buildings and are further divided into shopping mall internal shops and other internal shops. Shopping mall internal shops are considered visible consumption spaces, while other internal shops that do not have storefronts connected to public spaces and primarily operate through online platforms are considered invisible consumption

spaces. Specifically, within the POI data, places that meet the three conditions of ‘not being on the first floor,’ ‘not located within a shopping mall,’ and ‘having non-empty online reviews’ are identified as invisible consumption spaces.

The floor level information is derived from the address text within the POI data. When the address contains floor level information, the corresponding floor level is determined by searching, extracting, and standardising specific format key fields. If the address does not contain this information, it suggests that there is no requirement to specify the floor level in people's perception, and therefore, the default floor level is considered to be 1. Consequently, a floor level attribute label can be assigned to all POI data. The screening of internal shops in the shopping mall is completed using ArcGIS. POI data located within the shopping mall area, with a floor level less than or equal to the total number of floors of the shopping mall building, are considered shopping mall internal shops and are excluded. In addition to the store POI data, the attribute data of the buildings where invisible consumption spaces are located mainly come from relevant websites and field surveys (Table 2).

Table 2. Summary of data on buildings

Basic attribute	Name, type (office/commercial/residential/hotel, etc.), age, number of floors, standard floor area, standard floor height
Economic attribute	Sale price (10,000 yuan/m ²), rent price (yuan/m ² /day), property fee (yuan/m ² /month)
Management attribute	Owner property rights, property management, access control
Facility attribute	Independent water supply

Data source: The basic attributes, economic attributes, and property information of office/commercial/residential buildings are obtained from Diandianzu.com, Fang.com, and Anjuke.com. Additional information is collected through field surveys.

3.2 Spatial Distribution Characteristics of Invisible Consumption Spaces in Nanjing Old City

After the aforementioned data processing, it was ultimately determined that there are a total of 1,919 invisible consumption spaces in Nanjing old city (Figure 1, Table 3). It can be observed that spaces in the categories of life services, educational services, and entertainment services constitute the main components of the invisible consumption spaces. Compared to traditional stores, these spaces, although smaller in scale, are characterised by more distinctive operations and offer more customised and experiential services. This enables them to compete differently from traditional business and appeal more strongly to their target demographic, which is mainly young people.

Table 3. List of types, representative shops, and classification statistics of invisible consumption space in Nanjing old city

Types	Representative shops	Numbers	Proportion (%)
Catering services	Cat cafe, handmade dessert shop, private bakery, etc.	74	4

Shopping services	Suit customisation studio, jewelry customisation studio, etc.	56	3
Educational services	Foreign language learning, after-school tutoring, art training institutions, etc.	452	24
Life services	Hair salon, nail art studio, photo studio, massage parlour, etc.	1062	55
Entertainment services	Escape game room, private cinema, board game bar, etc.	132	7
Sports and leisure services	Fitness studio, Yoga studio, Taekwondo studio, etc.	103	5
Medical services	Postpartum recovery centre, psychological counselling centre, oral clinic, etc.	40	2
Total		1919	100

Data source: The author collated the POI data obtained by the Gaode Open Platform.



Figure 1. Spatial distribution of invisible consumption space in Nanjing old city

3.2.1 Distribution Characteristics: Central Agglomeration and Multi-Polar Clustering

This article utilises the Kernel Density Estimation (KDE) method, based on ArcGIS, to analyse the distribution of invisible consumption spaces in Nanjing old city. KDE measures the density of features around any given grid cell, describing the spatial aggregation state of geographical objects (Shi, 2010), and is a common method in spatial analysis. In this study, the Natural Breaks (Jenks) classification method is used to divide the data into six classes, which are then utilised to analyse the levels of aggregation of different poles (Figure 2). Multi-ring buffer zones are established around the city centre at 600-metre intervals to count the number of invisible consumption spaces and to construct a Lorenz curve. This curve is utilised to assess the level of aggregation centred around the city centre (Figure 3, Figure 4).



Figure 2. Natural Breaks (Jenks) classification by KDE analysis of the invisible consumption spaces in Nanjing old city

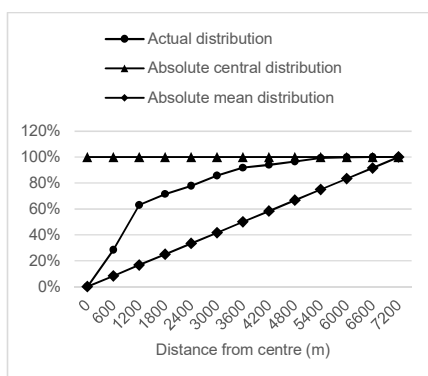


Figure 3. Lorenz curve for invisible consumption space in Nanjing old city

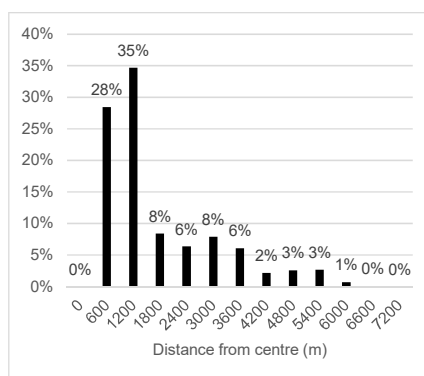


Figure 4. Statistics of invisible consumption spaces in Nanjing old city

Firstly, there is an overarching characteristic of central agglomeration. A distinct agglomeration is evident within the Xinjiekou CBD area, and the convex shape of the Lorenz curve further confirms this observation. More than 70% of the invisible consumption spaces are distributed within a 2000m radius around Xinjiekou. Additionally, secondary agglomerations can be observed in sub-centres such as Hunanlu and Daxinggong.

Secondly, on a local level, there is a characteristic of multi-polar clustering. Invisible consumption spaces are primarily located within buildings; hence, the agglomeration pattern shows a significant point aggregation. Within the Xinjiekou CBD area, they form multiple poles. The cost of operating a shop in high-rise buildings in the city centre area is much lower than that on streets and in shopping malls. As a type of microenterprise, invisible consumption

spaces are highly cost-sensitive. The multi-polar clustering formed by high-rise buildings is a result of spatial distribution driven by economic considerations.

3.2.2 Comparison of Invisible and Visible Consumption Space: Different in Proportion, Similar in Distribution

When comparing visible and invisible consumption spaces in the old city, it can be observed that there are a total of 6,561 visible consumption spaces corresponding to the categories of invisible consumption spaces, which is more than three times the number of invisible consumption spaces (Table 4). Among the visible consumption spaces, the number and proportion of shopping service spaces are much higher than those of invisible consumption spaces. These types of consumption spaces prioritise convenience and often rely on impulse buying, requiring increased visibility and accessibility. In contrast, invisible consumption spaces are mainly concentrated in experiential consumption types such as life services, entertainment, and sports and leisure.

Table 4. Numbers and Proportion of invisible and visible consumption spaces in Nanjing old city

Types	Invisible consumption spaces		Visible consumption spaces		Invisibility ratio
	Numbers	Proportion (%)	Numbers	Proportion (%)	
Catering services	74	4	789	12	0.094
Shopping services	56	3	1595	24	0.035
Educational services	452	24	713	11	0.634
Life services	1062	55	2682	41	0.396
Entertainment services	132	7	469	7	0.281
Sports and leisure services	103	5	150	2	0.687
Medical services	40	2	163	3	0.245
Total	1919	100	6561	100	0.292

Data source: The author collated the POI data obtained by the Gaode Open Platform.

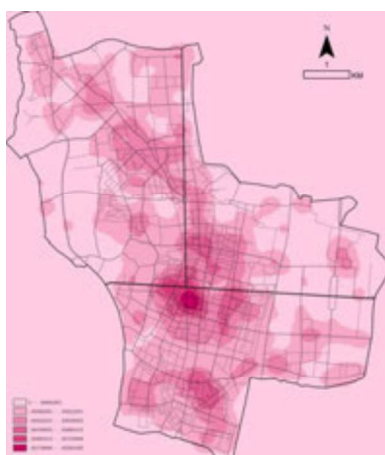


Figure 5. Natural Breaks (Jenks) classification by KDE analysis of the visible consumption spaces in Nanjing old city

In terms of spatial distribution, a comparison of KDE analysis of visible and invisible spaces (Figure 2, Figure 5) shows that the overall distribution of both types of spaces is generally similar and does not exhibit significant spatial differentiation. The distribution of visible consumption spaces is relatively more extensive. In terms of density, the highest level of agglomeration for both visible and invisible consumption spaces is located in the Xinjiekou CBD area, with secondary agglomerations appearing in several sub-centres. The most apparent difference in the distribution of visible and invisible consumption spaces is observed in the Fuzimiao area. As a traditional commercial sub-centre of Nanjing, the number of invisible consumption spaces is very limited. This is mainly because the Fuzimiao area, being historical and cultural blocks, is characterised by low and multi-storey buildings, which lack the high-rise buildings required for invisible consumption spaces.

4 Micro Site Selection Influencing Factors of Invisible Consumption Spaces

4.1 Research Methods

This article selects invisible consumption spaces in the Xinjiekou and Daxinggong areas (Figure 6) to analyse the factors influencing site selection. The reasons for choosing this area are twofold. Firstly, the Xinjiekou and Daxinggong areas are the most concentrated and representative areas for the distribution of invisible consumption spaces. Secondly, as the central business area of the old city of Nanjing, it has a long history, a prosperous commercial environment, and a rich variety of spatial, functional, and economic attributes of buildings, which facilitates comparative research.

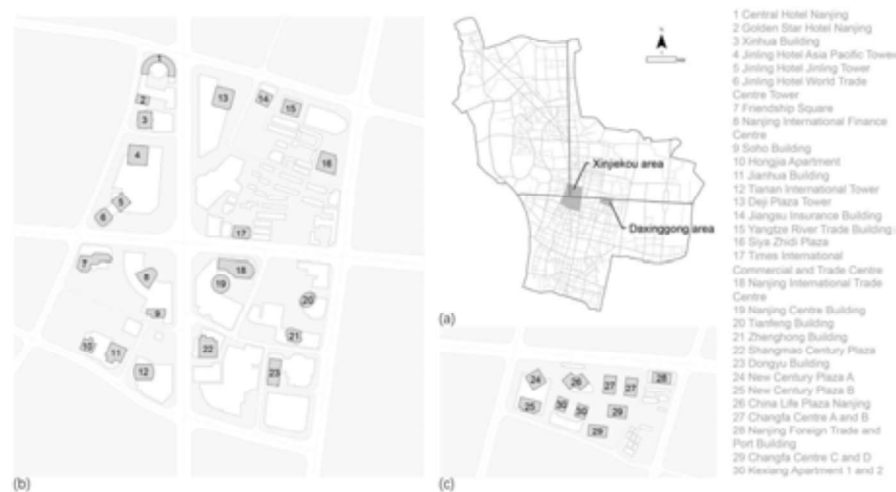


Figure 6. The research scope of Xinjiekou and Daxinggong areas

(a) Xinjiekou and Daxinggong areas in Nanjing old city

(b) Xinjiekou area and buildings

(c) Daxinggong area and buildings

The main analytical methods used in this study to research site selection factors are regression analysis and decision tree algorithms. The decision tree algorithms are inductive learning algorithms based on example data. It is commonly used to construct classification rules and form classifiers using example data. It is also used for predicting and mining unknown data and is widely applied in the fields of economic statistics and machine learning (Safavian and Landgrebe, 1991). It is also utilised in geographical space research, particularly in remote sensing information processing and urban address identification. The decision tree algorithms have the advantages of fast speed, high accuracy, easily understandable rules, and a relatively small computational load. They are suitable for both large and small sample sizes, as well as for continuous and discrete data. The basic idea is to use a hierarchical form, selecting different attribute conditions to make the most effective division of the set until significant category subsets are formed. Each path from the root to the leaf node corresponds to an extracted rule. The sample size, data characteristics, and the iterative and comprehensive relationship between the independent and dependent variables in this study fit well with the application conditions of the decision tree algorithms.

4.2 Analysis of Influencing Factors

Within the Xinjiekou and Daxinggong areas, there are 424 invisible consumption spaces spread across 30 buildings. Based on the number of stores within the building and the categories of store types (stores in a category are ≥ 5), buildings can be categorised into three types: first, buildings with almost no distribution of stores; second, buildings with some specific categories of stores; and third, buildings with a large number of various types of stores.

Before analysing the influencing factors, a single-factor screening is used to reduce irrelevant interference items. Based on the classification and quantification attributes of the variables, correlation, variance, chi-square, and linear regression are used to verify significance ($p \leq 0.05$). The results of the single-factor screening preliminarily indicate that the site selection of invisible consumption spaces is related to building types, rental and property costs, building owner property rights, building access control, and building independent water supply, while the store floor levels, store categories, store ratings, consumption per person, and building age are irrelevant variables. Further regression analysis indicates that the clustering of invisible consumption spaces around commercial-residential buildings is the most effective factor in explaining the distribution of these spaces. In fact, in the Xinjiekou and Daxinggong areas, almost all buildings with a large number of invisible consumption spaces are commercial-residential buildings. The tendency for invisible consumption spaces to be concentrated in commercial-residential buildings is highly significant.

On this basis, the decision tree algorithms are further utilised to analyse the influencing factors through a hierarchical classification method. The dependent variable is the three situations of the buildings with invisible consumption space, with the growing method set to CRT. The results show (Figure 7) that rental and property costs, owner property rights, access control, and independent water supply have a significant impact on the site selection of invisible consumption spaces.

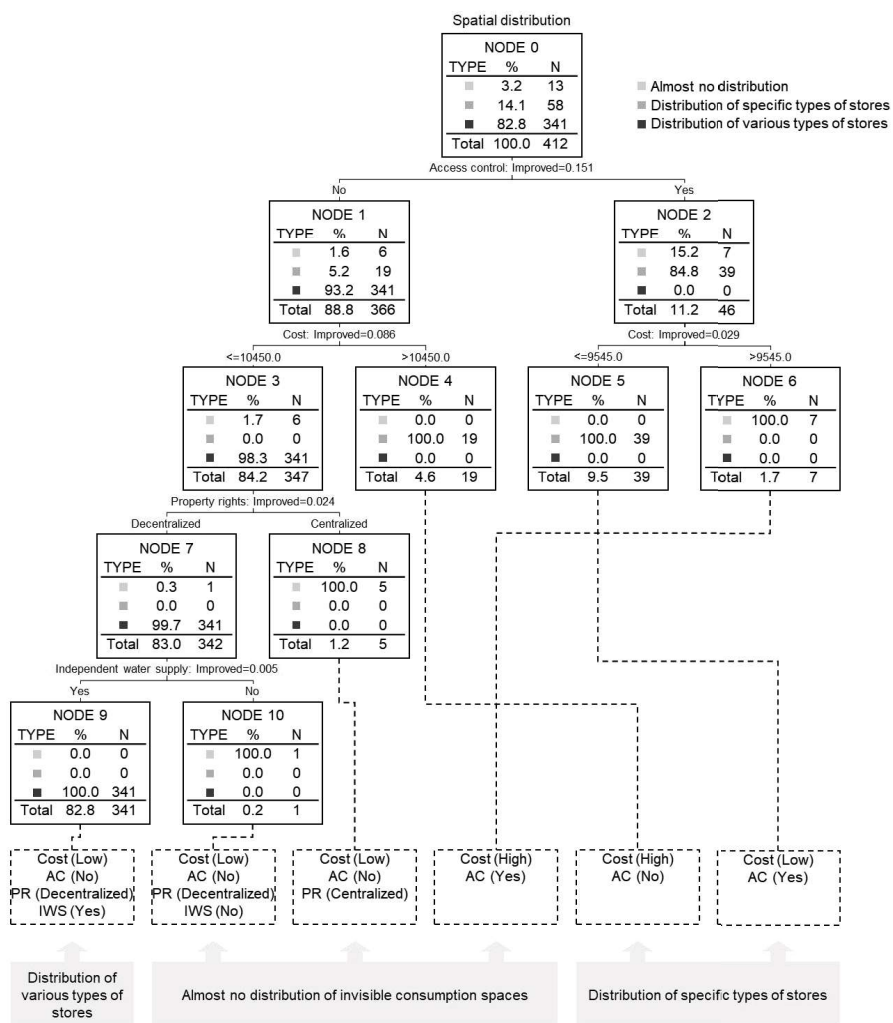


Figure 7. Process and results of decision tree algorithm

Specifically, the owner property rights, property management, and cost attributes of the buildings affect the numbers and types of invisible consumption spaces. Figure 7 shows that

the influencing factors of the three situations are different. Leaf node 1 indicates that when costs are low, owner property rights are decentralised, there is no strict access control, and there is an independent water supply, there are a large number of various types of stores present in the building. Leaf nodes 4 and 5 indicate that when costs are high or low but strict access control is in place, only specific types of stores are present in the building. Stores in buildings with strict access control are all appointment-based, membership-based life service spaces such as beauty salons and clubs. High-cost buildings only have a small number of language learning and study abroad institutions. Leaf nodes 2, 3, and 6 indicate that in cases where there is no independent water supply, property rights are consolidated, costs are high, and strict access control is enforced, there are almost no invisible consumption spaces within the building. This includes buildings with consolidated property rights that are not leased out, as well as high-end office buildings.

5 Conclusion and Discussion

5.1 Conclusion

Invisible consumption spaces, facilitated by the Internet and developed through O2O methods, represent a new form of consumption spaces in cities that has grown to a significant scale and cannot be ignored. In terms of spatial distribution, there is a macro characteristic of agglomeration towards central areas. This suggests that although invisible consumption spaces operate through the Internet, as physical consumption spaces they are still influenced by spatial elements in central areas. There is a micro characteristic of multi-polar clustering, with high-rise commercial-residential buildings serving as the main carriers for the clustering of invisible consumption spaces. This choice is based on multiple considerations, including cost, management, and support facilities.

5.1.1 The Spatial Distribution of Invisible Consumption Spaces Conforms to the Rule of General Consumption Space

As consumption spaces operate through O2O methods, traditional geographical theories still play a role in the site selection of invisible consumption spaces. The analysis in the previous text shows that the distribution of invisible consumption spaces is generally similar to that of visible consumption spaces. Firstly, on a macro level, the agglomeration centres of invisible consumption spaces are still the traditional business centres of Nanjing. Although the cognitive path of invisible consumption spaces is in cyberspace, they still need to complete the consumption in physical space. Therefore, factors such as traffic accessibility and commercial agglomeration effects, derived from geographical theories, still play an important role in their site selection. Secondly, compared with visible consumption spaces, invisible consumption spaces have a higher degree of agglomeration, showing characteristics of polar clustering in microform; that is, they are more concentrated in a particular building. Thirdly, there are significant differences in the composition and proportion of business formats between visible and invisible consumption spaces. The proportion of life services, entertainment, and sports and leisure in invisible consumption spaces is higher. This is related to the personalised and

experiential characteristics of these business formats and also reflects people's demand for diverse consumption spaces.

5.1.2 The Factor of Cost Leads to the Clustering of Invisible Consumption Spaces to Commercial-Residential Buildings in the City Centre

The commercial and service industry is cost-sensitive, and rent has a profound impact on the selection of commercial locations. This is also evident in the site selection of invisible consumption spaces. Firstly, by examining the cost factors, it is found that compared with other commercial spaces, the buildings where invisible consumption spaces are concentrated mostly have lower rent costs. Only business formats with stronger tenancy capabilities, such as foreign language training and study abroad counselling institutions, choose to locate in buildings with higher costs. Cost has become a determining factor for the types of businesses that can operate in these locations. Secondly, the analysis in the previous text revealed that invisible consumption spaces tend to favour commercial-residential buildings for their operations. Commercial-residential buildings emerged in the 1980s in some metropolises and have evolved to the present day. They are often criticised for their resource consumption, disaster prevention capabilities, environmental quality, and community atmosphere. This criticism has led to their rents being much lower than the average level in the same location. Against the backdrop of the internet era, the low rental costs of commercial-residential buildings happen to meet the needs of invisible consumption spaces, becoming a fertile ground for the development of invisible consumption spaces.

5.1.3 Management and Support Are Crucial Factors that Constrain the Distribution of Invisible Consumption Spaces

As consumption spaces within buildings, the spatial distribution of invisible consumption spaces is greatly constrained by the management and support of the buildings. Firstly, the impact of property rights on the distribution of invisible consumption spaces is mainly reflected in the differentiation between buildings with unified property rights and those with dispersed property rights in their approach to the emergence of invisible consumption spaces. High-end office buildings with integrated property rights, taking into account the overall environment and image, often carry out unified tenant recruitment, unintentionally excluding small and distinctive invisible consumption spaces. In contrast, commercial-residential buildings with dispersed property rights are controlled by different owners, and thus, under reasonable market prices and within the scope of legal use, owners typically do not impose additional requirements or restrictions on the entities that enter.

Secondly, building access control is also a factor that restricts the entry of invisible consumption spaces. The frequent movement of people in and out conflicts with strict access control measures. Therefore, under a strict access control management model, the invisible consumption spaces within are typically high-end service institutions that function based on appointments or memberships.

Thirdly, building support systems plays a crucial role in the establishment of certain types of business models, particularly independent water supply, which is essential for businesses like hair salons and catering services. Some buildings are unable to attract these types of business formats due to the lack of individual water supply systems. Thus, management and support determine the differentiation of invisible consumption spaces at the building level.

5.2 Discussion and Outlook

5.2.1 Invisible Consumption Spaces Are a Novel Form of Urban Space Regeneration in the Internet Era

With the Internet gradually becoming deeply integrated into people's everyday lives, the form of urban regeneration is also shifting from a focus on physical space renewal to a more comprehensive compound regeneration. The process of urban regeneration can be seen, to some extent, as a multi-dimensional and multi-element space production process involving entrepreneurship, employment, and business space. As a type of micro-entrepreneurial space, invisible consumption spaces have their own value. For the city, invisible consumption spaces can significantly enhance the efficiency and value of inefficient high-rise buildings, inject new vitality into a large number of vacant buildings such as commercial-residential buildings, effectively regulate the mismatch of land use and building functions, and serve as a bottom-up innovative driving force in the revitalisation of the old city. In addition, invisible consumption spaces facilitate job creation, foster innovation, diversify consumption options, support the structural reform of urban everyday life consumption, and address the increasing demand for an improved quality of life. Some invisible consumption spaces have potential cultural value because they reflect global and local dramatic unity. Through reproduction on the Internet, they have evolved into a subcultural phenomenon.

5.2.2 The Interaction between Physical Space and Cyberspace Will Generate New Forms of Urban Space

The Internet has partially replaced the functional roles of physical space, subsequently bringing about changes in everyday lifestyles and the logic of spatial distribution, enriching the forms of consumption spaces. Online and offline consumption spaces are not mutually exclusive but have interactive, complementary, and interconnected relationships. Invisible and visible consumption spaces are not in complete competition but rather promote each other through differentiated competition to meet diverse needs. With the continuous development of ICT and the advent of the Internet of Everything, new consumption spaces represented by invisible consumption spaces will face more diverse and complex changes. They have broad development potential and offer promising prospects for research.

This article presents empirical research on the old city of Nanjing, revealing the distribution characteristics and influencing factors of invisible consumption spaces to some extent. However, the study utilises POI data from a single platform, and the accuracy, comprehensiveness, and timeliness of the data still necessitate cross-verification with multiple data sources. The research

presented in this article is just a starting point, and there is a need for further exploration in areas such as the relationship between the distribution of invisible consumption spaces and urban structural elements, horizontal comparative studies between different cities, and longitudinal studies on historical evolution.

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